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Title: Do changes in objective and subjective family income predict change in children's diets over time? Unique insights using a longitudinal cohort study and fixed effects analysis

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ABSTRACT

Background: While an association has been established between low income and poor diet using cross-sectional data, such analysis cannot account for confounding by unobserved characteristics correlated with income and diet, and changes in income and diet cannot be tracked over time. This paper, using longitudinal panel data, explores whether falls in objective and subjective family income predict deterioration in children's diets over time.

Methods: This paper uses panel data from the nationally representative birth cohort study Growing Up in Scotland. 3279 families have valid data on all dependent, independent and control variables for both time points. Dietary data were collected using maternal recall at sweeps 2 and 5 when the children were aged 22 and 58 months respectively. Mothers reported on children's variety of consumption of vegetables, fruit, and on the frequency of consumption of crisps, sweets, and sugary drinks. The dietary variables were ordinal and were analysed using multivariate fixed effects ordinal logistic regression models.

Results: Controlling for time-varying confounders (children's food fussiness, maternal social class, maternal education, family composition, maternal employment) and for family and child time-invariant characteristics, moving from the highest to the lowest income band was linked to a smaller chance of increased fruit variety from 22 to 58 months, (OR=0.42, 95% CI 0.21 to 0.82). Mothers who transitioned from 'living very comfortably' to 'finding it very difficult' to cope on current income had children who consumed fewer fruit varieties over time (OR=0.40, 95% CI 0.19 to 0.85), and who increased their frequency of consumption of crisps (OR=2.03, 95% CI 1.05 to 3.94) and sweets (OR=2.23, 95% CI 1.18 to 4.20).

Conclusion: The diets of young children in Scotland deteriorated between the ages of 2 and 5 years across the entire socioeconomic spectrum. Additionally, deterioration in subjective income predicted less healthy diets for children.

What is already known:

Studies have shown associations between income and food poverty.

But due to study designs in the existing literature, a causal link cannot be inferred.

Very few studies focus on the relationships between income and the diets of very young children.

What this research adds:

Using panel data for a nationally representative cohort of families in Scotland, we find that changes in real income are a poor predictor of changes in diet among children from age 2 to 5.

Perceived reductions in subjective income, however, significantly predicted deteriorations in children's diets.

Young children's diets deteriorate across the socioeconomic spectrum during this period possibly due the neophobic developmental phase of childhood.

Title: Do changes in objective and subjective family income predict change in children's diets over time? Unique insights using a longitudinal cohort study and fixed effects analysis

INTRODUCTION

There is a strong history of research on the association between poverty and diet[1–12]; although reasons why poverty should lead to the consumption of poorer quality foods are not made explicit. Darmon and Drewnowski posit that the causal mechanisms may be that a) ‘healthy’ foods are frequently more expensive, b) families in poverty live in areas with lower availability of healthy food options or c) families on lower incomes differ in terms of their education and food culture, leading them to make less ‘healthy’ food choices.[1,5]

In a review of UK evidence from the 1990s, Nelson et al establish that children and adults living in economic disadvantage are also nutritionally disadvantaged.[8] Data from the UK Family Expenditure Survey, in contrast, show that between the periods 1995-1998 and 2000-2003 low-income families were closing the gap on expenditure on fruit and vegetables.[12] More recent evidence suggests that income remains a key predictor of food insecurity in children and adults in the UK[13,14] and that the recent economic downturn is exacerbating the difficulties in eating healthily on a low income.[15] Thus far research has not explored the effects on diet of changes in income over time. Moreover, the extant body of research focuses primarily on adults: there is a paucity of research on how change in income affects the diets of young children in the UK. A further layer of complexity to any research on changes in children’s diet arises from the neophobic food phase children experience between 2 and 4 years of age[16,17], which is a strong predictor of change in diet that may impede the identification of associations between income and diet for this age

group. Food neophobia has been observed in other mammals as well as in humans, and is considered to be a biological developmental phase all children negotiate/experience, a potentially adaptive response for the avoidance of toxic foods.[18,19]

This research uses nationally representative birth cohort data from Scotland to look at the extent to which *changes* in objective and subjective family income predict *changes* in children's consumption of different food groups from 2 to 5 years of age. We hypothesise that negative changes in family subjective and objective income will result in decreased consumption of foods recommended by public health bodies for a healthy diet[20] and increased consumption of nutrient poor foods.[21]

METHODS

Sample

For the analysis we used sweeps 2, 4 and 5 of the Growing Up in Scotland (GUS) longitudinal birth cohort survey. This was an appropriate data source because it a) had a nationally representative sample; b) collected detailed information on very young children's diets and parental income; and c) collected data annually. The birth cohort comprised 5216 babies born in June 2004-May 2005 and aged 10 months old at sweep 1. Data on income, collected annually, and data on dietary habits of children at ages 2 and 5 were collected from the mother via face-to-face structured interviews.[22] As with all longitudinal surveys, attrition is a weakness of GUS; however, its response rates are comparatively high. By sweep 5, when the children were approximately 5 years of age, the total response rate was 73% of the original starting sample at sweep 1. A comprehensive analysis of survey attrition has been provided elsewhere.[22]

Box 1 details the changes in the sample size after accounting for survey and item non-response. Descriptive statistics in tables 1 and 2 used all cases with valid data for each variable at each time point. Individual fixed effects models (table 3), and follow-up analysis comparing households where income changes and stayed the same over time (table 4), used data only from children who moved from one category to another on the dependent variable so the total sample size for each model in the analysis is lower and varies depending on the food item in question (N:3279).

Box 1 Working sample for panel analysis

- Starting sample at sweep 1: 5216
- 706 cases dropped out of survey at age 2: 4510 remaining
- 14 cases removed with no valid data on diet measures: 4496
- 277 cases removed with no valid data for independent variables at age 2: 4219 remaining
- 663 cases present at sweep 2 dropped out for sweep 5: 3556 remaining
- 28 cases removed with no valid data on diet measures at age 5: 3528 remaining
- 249 cases removed with no valid data on equivalised income at age 5^a: 3279 remaining

a. Cases with no valid data on subjective income collected at sweep 4 were also removed at this stage.

Dependent variables

Food consumption questions

The dependent variables comprised five questions on food consumption asked to each child's mother at 2 and 5 years of age (table 1). Responses to these questions were based on maternal recall and so may be affected by recall bias and by maternal desires to provide socially acceptable answers. As nutrition policy in Scotland does not provide quantitative guidelines for toddlers' food consumption, but rather recommends a varied diet, so the questions in this Scottish Government commissioned survey were devised to monitor food consumption frequency and variety, not quantity.

Table 1 Dependent variable - descriptive statistics (weighted %, unweighted N).

Original Food Questions	Age 2		Age 5	
	N	%	N	%
How many different types of vegetables on a typical day	Total: 4503		Total: 3807	
None	266	6.4	991	27.9
One	1037	23.8	814	21.1
Two or three	2769	60.4	1659	42.7
Four or five	382	8.3	310	7.6
More than five	49	1.1	33	0.8
How many different types of fruit on a typical day (excluding fruit juice)	Total: 4509		Total: 3818	
None	144	3.5	496	14.2
One	490	11.8	819	22.2
Two or three	2685	59.4	2064	52.9
Four or five	993	21.2	417	10.2
More than five	197	4.2	22	0.5
How often does child eat crisps	Total: 4509		Total: 3832	
More than once a day	488	11.4	105	3.6
Once a day	1512	34.2	699	19.8
5-6 times a week	5369	7.9	251	6.5
2-4 times a week	1245	27.1	1447	36.9
Once a week	462	10	717	17.8
1-3 times a month	168	3.5	334	8.1
Less often/never	265	5.9	279	7.3
How often does child eat sweets², chocolate	Total: 4507		Total: 3832	
More than once a day	494	11.8	330	9.6
Once a day	1378	31.4	1453	39
5-6 times a week	228	4.9	335	8.4
2-4 times a week	1402	30.2	1245	31.1
Once a week	551	11.9	319	8.1
1-3 times a month	204	4.3	74	1.9
Less often/never	250	5.5	76	2
How often does child drink soft drinks, not including diet or low-calorie drinks (excluding fruit juice)	Total: 4507		Total: 3831	
More than once a day	343	8.1	1042	28.7
Once a day	165	3.9	511	12.7
5-6 times a week	15	0.3	96	2.5
2-4 times a week	100	2.4	271	7.1
Once a week	145	3.3	207	5.3
1-3 times a month	136	3.1	145	3.5
Less often/never	3603	78.9	1559	40.2

1. All N values are based on un-weighted data

2. A term generally used for 'candy' in the United Kingdom.

The independent variables

Objective and subjective measures of income

Income data were obtained by asking the mother to select one of 17 income bands which reflected total household income before tax. Equivalised income was calculated using the Organisation for Economic Co-operation and Development [OECD] modified equivalence scales and procedure.[23] Income band thresholds for age 2 were adjusted for annual inflation when coding the age 5 income variable (total cumulative inflation of 8.3144% for 2006, 2007, 2009, see Table 2, note 1 for thresholds).

Data on subjective poverty, where mothers were asked how they *feel* they are managing on their present income, were collected at ages 2 and 4: responses provided at age 4 were used to represent responses at age 5 in the models. A final question used in the analysis asks mothers whether cost affected the types of food they gave their children. A test for internal consistency using objective income and the two questions on subjective income provided an alpha score of 0.56, and 0.59 for sweep 2 and sweep 5 respectively, indicating that subjective and objective income capture different dimensions of the same underlying construct. Descriptive statistics for all income variables and control variables used in the analysis are in table 2.

Control variables

To account for food neophobia a question on whether children ate a variety of foods was controlled for in the model. We controlled for characteristics that changed over time that

may also influence dietary habits, such as maternal education and maternal social class, when children were 2 and 5 years of age as research suggests that maternal education is a better predictor of infant nutrition than income or social class.[24–26] As maternal education changed only slightly between the time period under consideration (5% of mothers gained a higher qualification during this period) it is coded as a binary variable. In light of existing literature we also controlled for change in family composition [26,27] and change in maternal employment.[28]

Time-invariant characteristics

Although fixed effect models cannot estimate coefficients for variables that have no within-subject variation, all time invariant characteristics of families and children, such as the mother's ethnicity, her age at the birth of the sample child, and the child's gender are still by default controlled for in the analysis.

Table 2 Descriptive statistics - Independent variables at age 2 (weighted %)

	At age 2		At age 5	
	N	%	N	%
Equivalised Income²	Total:4260		Total:3606	
Less than 5k	202	5.6	90	3.2
5k – 9.9k	719	19.6	417	15
10k – 19.9k	1166	27.8	1022	30.5
20k – 29.9k	1074	23.8	914	23.5
30k – 39.9k	597	12.8	644	15.5
40k and more	503	10.5	519	12.2
Feelings about present income	Total:4507		Total:3735	
Living very comfortably	356	7.5	376	8.7
Living comfortably	1609	34	1469	34.9
Coping	1903	43	1622	42.1
Finding it difficult	503	12.1	427	11.4
Finding it very difficult	137	3.4	96	2.8
Cost of food affects what food child is given	Total:4504		Total:3832	
A lot/A fair amount	285	7	405	11.5
A little	861	19.1	1151	30
Not at all	3359	73.9	2276	58.5
If child eats a variety of foods	Total:4505		Total:3832	
Eats most things	2622	58.8	1783	47.5
Eats a reasonable variety	1274	27.3	1198	29.3
Is a fussy eater	610	13.9	847	23.1
NS-SEC	Total:4511		Total:3832	
Professional/Managerial	2586	54	2631	62.8
Intermediate	500	11.1	560	15.3
Routine and never worked	1425	35	641	21.9
Maternal education	Total:4480		Total:3806	
No degree	3147	73.1	2565	71.9
Degree	1333	26.9	1241	28.1
Family type	Total:4511		Total:3832	
Single parent	747	19.8	597	19.3
Couple	3764	80.2	3235	80.7
Maternal employment	Total:4510		Total:3826	
Full-time (>=35h)	689	14.7	658	15.9
Part-time (<35h)	2148	45.3	1977	48.7
Not in work	1673	40	1191	35.3

1. All N values are based on un-weighted data.

2. K = Thousands. Inflation adjusted equivalised income bands are used for when children are 5 years old in 2009, based on the stated income bands for when children are 2 years old in 2006. These are <£5416; £5416 to <£10831; £10831 to <£21663; £21663 to <£32494; £32494 to <£43326; £43326 or more.

Analytical approach & statistics

Fixed effects models control for unmeasured confounding characteristics of families and individuals that change slowly over time, such as culture, food cultures and specific family meal rituals,[29–31] which may mask the true relationship between income and diet.[32] This method can potentially reveal whether there is a direct and arguably causal association between income fluctuations and changes in children's diets.

Since the dependent variables in our data were measured on an ordinal scale we used ordered logistic fixed effects regression technique (Stata 12.1).[33] All measures of income and all control variables were included in the model together. Descriptive analyses for eating habits and independent variables in tables 1 and 2 were weighted with appropriate sample weights to adjust for non-random non-response bias and for the different selection probability of children. As the use of weights is not possible when using fixed effects ordinal logistic regression the results in Table 3 are unweighted. The robustness of results was assessed by running weighted and non-weighted fixed effects OLS regression models on the same data, which showed that coefficients and standard errors across models were very similar, and in most cases identical (Supplemental Table A). Collinearity diagnostics indicated that the Variance Inflation Factor (VIF) for each variable was smaller than the commonly used threshold of 10.[34]

RESULTS

Table 3 presents the multivariate fixed effects ordinal logistic regression models for each of the five food items explored. All five dependent variables were coded to reflect the odds of increasing the consumption of more types of fruits and vegetables and for increasing the consumption frequency of crisps, sweets and sugary drinks.

Time

As children reached 5 years of age, they were statistically significantly: (a) less likely to consume a greater variety of vegetables and fruit (OR=0.70, 95% CI 0.67 to 0.73 and OR=0.58, 95% CI 0.56 to 0.61 respectively); (b) less likely to have increased their crisp consumption (OR=0.66, 95% CI 0.64 to 0.69); (c) more likely to consume sweets (OR=1.25, 95% CI 1.20 to 1.30); and (d) more likely to consume sugary drinks more frequently (OR=1.98, 95% CI 1.86 to 2.09) compared to their consumption at age 2.

Income

Controlling for changes in subjective income, change in equivalised income over time only predicted change in consumption of fruit to some extent, where moving from the highest to the lowest income band was linked to children having a smaller chance of consuming a greater variety of fruit from age 2 to age 5 (OR=0.42, 95% CI 0.21 to 0.82).

The chances of children increasing their consumption of a variety of vegetables fell as feelings about family income deteriorated over time, controlling for changes in equivalised income. For example, mothers who changed from 'living very comfortably' to 'finding it difficult' to cope on their family income had children who were less likely to have increased

the variety of vegetables they consumed over time (OR=0.62, 95% CI 0.39 to 0.99). Mothers who transition from 'living very comfortably' towards 'finding it very difficult' had children who consumed fewer fruit varieties over time (OR=0.40, 95% CI 0.19 to 0.85) and increased their consumption of crisps (OR=2.03, 95% CI 1.05 to 3.94) and sweets (OR=2.23, 95% CI 1.18 to 4.20) from ages 2 to 5.

Controlling for changes in equivalised income, changes in maternal perceptions of whether food costs affected what food children were given did not predict change in consumption of foods well. Only in cases where mothers changed from feeling that food costs influenced foods given to children 'not at all' to feeling they influenced food choices 'a lot/a fair amount' did sweet consumption decrease from 2 to 5 years or age (OR=0.69, 95% CI 0.49 to 0.96). None of the income measures predicted change in consumption of sugary drinks.

Control variables

There was an incremental negative association between increasing food pickiness among children and vegetable and fruit consumption, and a positive association with crisp consumption. Children who changed from 'eats most things' to 'is a fussy eater' were less likely to have increased their vegetable and fruit consumption (OR=0.25, 95% CI 0.19 to 0.33 and OR=0.49, 95% CI 0.36 to 0.66 respectively). Children who transitioned from 'eats most things' to 'is a fussy eater' were more likely to have increased their consumption of crisps (OR=1.54, 95% CI 1.17 to 2.02).

Nagelkerke's pseudo R-square measure suggests that our analytical model best predicts change in consumption of fruit and sugary drinks, predicts change in vegetable and crisp consumption less well, and does not predict change in sweet consumption well.

Table 3 Fixed Effects Ordinal Logistic Regression Models adjusted for time-varying confounders² - unweighted data.

	Vegetables - Increase in variety		Fruit ⁴ – Increase in variety		Crisps – Increase in consumption frequency		Sweets – Increase in consumption frequency		Sugary drinks – Increase in consumption frequency	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Time										
Ref: Age 2	1.00		1.00		1.00		1.00		1.00	
Age 5	0.70***	[0.67,0.73]	0.58***	[0.56,0.61]	0.66***	[0.64,0.69]	1.25***	[1.20,1.30]	1.98***	[1.86,2.09]
Equivalised Income³										
Ref: 40K of more	1.00		1.00		1.00		1.00		1.00	
Less than 5k	1.08	[0.58,2.03]	0.42*	[0.21,0.82]	0.62	[0.33,1.20]	1.50	[0.80,2.82]	1.62	[0.62,4.24]
5k – 9.9k	1.37	[0.85,2.22]	1.00	[0.57,1.74]	0.86	[0.53,1.40]	1.56	[0.96,2.55]	1.61	[0.83,3.10]
10k – 19.9k	1.31	[0.86,2.00]	0.80	[0.50,1.28]	0.97	[0.64,1.45]	1.37	[0.92,2.06]	1.33	[0.78,2.25]
20k – 29.9k	1.25	[0.85,1.84]	0.73	[0.47,1.14]	1.02	[0.70,1.47]	1.35	[0.94,1.95]	1.61	[0.98,2.64]
30k – 39.9k	1.21	[0.88,1.65]	0.97	[0.69,1.36]	0.86	[0.64,1.15]	1.21	[0.90,1.62]	1.27	[0.83,1.96]
Feelings about how family is coping on present income										
Ref: Living very comfortably	1.00		1.00		1.00		1.00		1.00	
Living comfortably	0.71	[0.51,1.01]	0.87	[0.59,1.28]	1.58*	[1.11,2.25]	1.36	[0.98,1.88]	0.98	[0.61,1.57]
Coping	0.65*	[0.44,0.98]	0.98	[0.63,1.50]	1.55*	[1.05,2.30]	1.52*	[1.06,2.20]	0.84	[0.50,1.44]
Finding it difficult	0.62*	[0.39,0.99]	1.10	[0.65,1.87]	1.46	[0.91,2.36]	2.23***	[1.41,3.51]	1.07	[0.56,2.02]
Finding it very difficult	0.54	[0.27,1.06]	0.40*	[0.19,0.85]	2.03*	[1.05,3.94]	2.23*	[1.18,4.20]	0.90	[0.36,2.23]
Cost of food affects what food child is given										
Ref: Not at all	1.00		1.00		1.00		1.00		1.00	
A lot/a fair amount	1.06	[0.78,1.44]	0.97	[0.67,1.40]	0.94	[0.67,1.30]	0.69*	[0.49,0.96]	0.76	[0.49,1.20]
A little	1.00	[0.82,1.23]	1.04	[0.82,1.32]	0.98	[0.81,1.18]	1.06	[0.87,1.29]	0.89	[0.67,1.18]
If child eats a variety of foods										
Ref: Eats most things	1.00		1.00		1.00		1.00		1.00	
Eats a reasonable variety	0.60***	[0.50,0.73]	0.76*	[0.60,0.95]	1.15	[0.95,1.40]	0.96	[0.79,1.16]	1.26	[0.97,1.63]
Is a fussy eater	0.25***	[0.19,0.33]	0.49***	[0.36,0.66]	1.54**	[1.17,2.02]	0.93	[0.72,1.20]	1.17	[0.81,1.68]
Unweighted N	1941 (from 3279)		1862 (from 3279)		2337(from 3279)		2045(from 3279)		1991(from 3279)	
Nagelkerke R-square	0.30		0.45		0.30		0.11		0.58	

1. Significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 95% confidence intervals in brackets.

2. Adjusted for following time-varying characteristics: NS-SEC, maternal education, family composition, maternal employment

3. K = Thousands. Inflation adjusted equivalised income bands are used for when children are 5 years old in 2009, based on the stated income bands for when children are 2 years old in 2006. These are <£5416; £5416 to <£10831; £10831 to <£21663; £21663 to <£32494; £32494 to <£43326; £43326 or more.

4. Excluding fruit juice

Differences between changing and unchanging family income

Since families for whom income fluctuated may differ from those whose income stayed the same, the latter are by default not included in fixed effect analyses. Table 4 shows how children in families with both changing and unchanging income differed in terms of both changing and unchanging dietary habits. Changes in diet over time did not significantly differ between families where income increased or decreased. On the other hand, children in persistently low income homes were far more likely than those in persistently high income homes to have time-stable healthier eating habits at both age 2 and age 5. For example, compared to children in persistently low income families, those in persistently high income homes were significantly more likely to eat 2 or more types of vegetables (53.2% versus 25.9%), and more likely to eat sweets less than once per day (47.2% versus 20.5%). However, children in persistently low incomes were more likely to have improved their diet over time. For example, 9.7% of children in persistently low income homes increased their fruit variety consumption versus 2.2% in persistently high income homes.

Equivalised income indicators stayed unchanged for about half of the families in the sample (46%), and there were statistically significant differences between families who stayed the same and those who changed over time (not shown). It is important to note that households where equivalised income fell over time were more likely to be those in which mothers held managerial/professional occupations and had a degree, where there were two parents, and where mothers worked full-time.

Table 4 Association between different income and dietary trajectories over time¹

	Persistent low income (N:248)		Persistent middle income (N:879)		Persistent high income (N:368)		From higher to lower income (N:886)		From lower to higher income (N:898)		
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	N
Vegetable variety age 2 to 5											
Increased	12.7	[8.7-18.1]	10.5	[8.6-12.8]	7.5	[5.1-10.9]	9.3	[7.4-11.7]	10	[8.0-12.3]	314
Decreased	32.4	[27.0-38.2]	29	[25.9-32.3]	24.3	[20.8-28.2]	27.3	[24.9-29.8]	28.2	[24.9-31.7]	927
Unchanged - 2 or more types	25.9	[20.8-31.8]	40.3	[36.8-44.0]	53.2	[48.1-58.2]	47.3	[44.2-50.4]	38.9	[35.2-42.6]	1420
Unchanged – 1 or fewer types	29	[22.7-36.2]	20.2	[17.5-23.2]	15	[11.2-19.9]	16.1	[13.8-18.7]	23	[19.7-26.6]	618
	100.0		100.0		100.0		100.0		100.0		3279
Fruit² variety age 2 to 5											
Increased	9.7	[6.2-14.9]	4.5	[3.4-5.9]	2.2	[1.2-3.8]	4.4	[3.1-6.3]	6.3	[4.8-8.2]	156
Decreased	31.6	[26.0-37.8]	26.1	[23.0-29.3]	23.4	[20.0-27.1]	26.1	[23.4-29.0]	28.1	[24.9-31.4]	853
Unchanged - 2 or more types	39.2	[32.7-46.1]	60.3	[56.8-63.7]	70.4	[66.4-74.1]	62.8	[59.5-66.1]	55.6	[51.4-59.7]	2002
Unchanged – 1 or fewer types	19.4	[14.1-26.2]	9.2	[7.3-11.4]	4.1	[2.4-6.9]	6.6	[4.7-9.1]	10	[7.9-12.7]	268
	100.0		100.0		100.0		100.0		100.0		3279
Crisps frequency age 2 to 5											
Increased	7.9	[4.8-12.7]	8.4	[6.8-10.3]	7.1	[4.6-10.8]	5.4	[4.1-7.1]	7.3	[5.5-9.6]	219
Decreased	38.3	[33.0-43.9]	30.8	[27.5-34.4]	27.6	[22.8-32.9]	28.4	[25.3-31.8]	29.3	[26.0-33.0]	969
Unchanged - minimum once/day	27.4	[22.0-33.6]	15.2	[12.5-18.2]	6.3	[4.1-9.6]	14.3	[11.9-17.0]	15.4	[12.5-18.8]	448
Unchanged - less than once/day	26.4	[21.0-32.7]	45.6	[41.9-49.4]	59.1	[54.4-63.6]	51.9	[48.1-55.6]	47.9	[44.5-51.3]	1643
	100.0		100.0		100.0		100.0		100.0		3279
Sweets frequency age 2 to 5											
Increased	17.7	[13.2-23.2]	18.9	[16.3-21.8]	21.4	[17.6-25.8]	16.2	[13.9-18.9]	18.9	[16.3-21.8]	600
Decreased	20.5	[16.0-25.9]	12.2	[9.8-15.0]	11.2	[8.1-15.2]	11	[9.0-13.5]	14.7	[12.3-17.5]	418
Unchanged - minimum once/day	41.3	[34.3-48.7]	31.4	[27.4-35.6]	20.2	[16.3-24.9]	25.7	[22.7-29.0]	30.6	[27.1-34.2]	898
Unchanged - less than once/day	20.5	[15.5-26.5]	37.6	[33.7-41.6]	47.2	[41.6-52.9]	47	[42.9-51.2]	35.8	[32.3-39.4]	1363
	100.0		100.0		100.0		100.0		100.0		3279
Sugary drinks frequency age 2 to 5											
Increased	27.6	[23.1-32.7]	47.5	[43.8-51.2]	44.8	[39.2-50.6]	45.4	[42.0-48.9]	45.6	[41.7-49.7]	1494
Decreased	10.5	[6.7-15.9]	5.9	[4.4-7.8]	3.6	[2.2-5.8]	5.3	[3.8-7.5]	6.7	[4.7-9.3]	188
Unchanged – several times per month	31.7	[26.2-37.7]	11.6	[9.6-14.1]	8.1	[5.6-11.4]	13	[10.3-16.3]	16.5	[13.5-20.1]	439
Unchanged – less than once per month	30.2	[24.7-36.5]	35	[31.5-38.7]	43.5	[37.8-49.5]	36.2	[32.3-40.3]	31.2	[27.2-35.5]	1158
	100.0		100.0		100.0		100.0		100.0		3279

1.To facilitate interpretation, dietary variables have been dichotomised and equivalised income bands have been grouped into 3 categories. Columns capturing changing income reflect moving from one income band to another from child age 2 to 5.

2.Excluding fruit juice

DISCUSSION

The analysis presented in this paper concurs with the existing evidence that diets of young children deteriorate somewhat in early childhood.[16,17] For the children in this study, the variety of fruit and vegetables consumed fell, the frequency of consumption of sweets and sugary drinks increased, but, curiously, and against expectations, the frequency of consumption of crisps also fell to two thirds that at 2 years of age. It is unclear whether national healthy eating campaigns are behind this change and there appears to be no specific campaign particularly targeting the consumption of crisps more than other foods. Our results fit in with Scottish Health Survey data which suggest that between 2003 and 2008/9 the proportion of children eating crisps once a day or more fell from 52% to 36%.[35] This may indicate an overall change in eating habits triggered by prolonged investment in public health campaigns and/or the increase in regulation of the food provided in school and child care settings.[36]

With the exception of crisps, the variety of healthy foods consumed decreased and unhealthy foods were being eaten more often. This is a phenomenon noted in the wider literature which suggests that during the third year of life children across the socioeconomic spectrum develop a neophobic food phase,[37] refusing foods previously eaten and rejecting the tastes of new food, with vegetables, fruit and protein foods often being avoided.[16,17] Explanations other than, or additional to, food neophobia that may explain an overall deterioration in diet from age 2 to 5 could include increased agency in children and an increased demand and preference for energy dense foods,[38,39] or changes in eating habits resulting from changing child-care arrangements.[40,41]

The evidence is unequivocal that quality of diet in children at 2 years, but not at 5 years of age, is strongly associated with family income; however, it may be that other characteristics linked to family income are responsible. Fixed effects analyses clarify that, controlling for all such fixed characteristics, falls in equivalised income over time do not predict change in diet very well. Change in income status of families did not generally lead to an increase or decrease in the consumption of healthy or unhealthy foods in children between 2 and 5 years of age. This runs counterintuitive to our hypothesis that a decrease in income would result in a decrease in healthy food consumption and an increase in unhealthy food consumption.

Change in subjective income was better at capturing links between economic disadvantage and dietary change, though not for all food types. A reduction in consumption of vegetables and fruit and an increase in consumption of crisps and sweets were all significantly associated with negative feelings towards current income, in keeping with the original hypothesis. It appears that sweet consumption was particularly sensitive to fluctuations in subjective income. One theory is that parents offer sweets as a cheap treat during financially difficult times, but this was somewhat contradicted by the results which showed that mothers who changed from feeling that food costs influence what they fed their children ‘not at all’ to ‘a lot’ were less likely to have children with increased frequency of sweet consumption over time. No significant links between change in income and change in consumption frequency of sugary drinks were found, so although sweets and soft-drinks are high in sugar, income appears to influence consumption of these items differently. In the UK, sugary soft drinks are an integral part of the diet of adults and children in low income families and the main source of Non-Milk Extrinsic Sugars in the diets of children in low income families,[42] whereas sweets are perhaps purchased on a more spontaneous basis. It may be that perceived or actual changes in income are more likely to affect the spontaneous

daily purchases directed primarily at children rather than the weekly food shop for all the family.

An interesting finding is the relative usefulness of subjective income compared to equivalised income per se with this data. As discussed previously, income poverty and subjective poverty correlate but do not directly overlap.[43] When a family experiences a reduction in income the use of resources previously accumulated can delay subjective poverty.[44] Likewise, intra-familial transfer of resources, where family income is not equally distributed among family members, may result in divergent feelings on the ability to cope on present income between parents.[45] It is perhaps this perception of ability to cope on current income rather than income per se that guides parents' choices in food consumption. There is also, of course, the possibility that the original income data are inaccurate or that the equivalisation process introduces error or misadjusts families' income.

Limitations

One of the limitations of the study is that subjective income is an imperfect measure potentially affected by false consciousness, adaptation, intra-familial transfer of resources or reluctance to be subjected to the stigma of poverty.[43,46] Subjective and objective poverty do not overlap directly due to the lagged effect of income poverty on living standards.[44] However, there is a clear relationship between objective measures of deprivation and subjective deprivation.[47,48] A further limitation is that families where income does not change, or where eating habits do not change, do not contribute to the fixed effects models, and our analyses suggest that families for whom income changes are significantly different

to those for whom income does not change, and that differences in children's diet are far more pronounced between families in persistently low and high income than between families for whom incomes changed over time. For families who remained within the same income or food consumption categories over the surveyed time period, it is impossible to know using this analysis whether a link between their income and diet can be attributed to income and food costs per se, or to other characteristics of these families. Finally, fixed effects models can still suffer from bias resulting from unmeasured or un-measurable time-varying characteristics.

The key conclusion is that among families who experienced income change in the first years following the birth of a child, change in income, except to some extent subjective income, did not lead to changes in the consumption of healthy and unhealthy foods. The diets of children between 2 and 5 years of age do deteriorate, across the socioeconomic spectrum, for which other mechanisms must be present. We have discussed how food neophobia, as well as children's increasing agency, or changes in children's childcare arrangements might be some of the driving factors behind this change.

FOOTNOTES

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Contributorship statement: VS conceived and designed the study, and conducted the statistical analyses. VS and MT interpreted the data. VS and MT drafted the article and approved the final submitted version.

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Competing Interests

None declared.

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Data access: both authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing: GUS survey data can be accessed at <http://data-archive.ac.uk/>

Transparency declaration: The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no important aspects of the study have been omitted; any discrepancies from the study as planned have been explained.

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